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INNOVATIVE WORK ARRANGEMENTS

A CASE STUDY IN JOB ENRICHMENT

PHILIPS ELECTRONICS LIMITED
LEASIDE, ONTARIO

Number 17

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PHILIPS ELECTRONICS LIMITED
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by

Ian S. G. Meadows

RESEARCH BRANCH

ONTARIO MINISTRY OF LABOUR

July 1976

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Minister

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Deputy Minister

PREFACE

This is the third in a series of case studies on the theme of innovative work arrangements. Each study describes the experience of a different industrial or commercial organization in Ontario which has made some substantial change in the work arrangements of its employees. The purpose of publishing these case studies is to make available information on innovations in the workplace which may improve the quality of work life for employees in Ontario. These studies describe the constraints, particularly the technological ones, on such innovations as well as some of the problems encountered in making changes in work arrangements. Also, the studies give the author's impressions as to the benefits attained.

The Ministry of Labour acknowledges the cooperation from Philips Electronics Limited, without which this study would not have been possible.

M. L. Skolnik
Director
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INTRODUCTION

Philips Electronics Limited is part of a worldwide manufacturing organization which employs approximately 300,000 people. In the design of jobs, with concern for both employee welfare and the economics of production, Philips takes an active interest in job enrichment and related ideas. This case study is concerned with a job enrichment programme in Philips' Television Production Department at their plant in Leaside, Ontario.

The main purpose of this study is to examine the changes in job design and layout made to-date in the interests of job enrichment, and the effects of these changes on employee and management interests. In so doing, it is our aim to illustrate the kinds of opportunities that exist for improving working arrangements in industry, as well as the problems and limitations that can be encountered.

The operation concerned is the assembly of colour television sets. All component parts are purchased. The plant constructs sub-assemblies or "modules" which are then mounted, together with picture tubes, speakers, etc., in ready-made cabinets. The cabinets are manufactured by Philips at their Strathroy, Ontario plant. The finished sets are tested and adjusted and packed ready for distribution. The entire assembly operation is carried out in one open plan area.

The report begins with a background discussion of assembly line production systems in general, and the basis of Philips' concern for the effects of this kind of work arrangement on employee morale. The next section describes in some detail the experience gained at Leaside in re-designing jobs and work arrangements. Two particular sub-assembly operations are discussed: front control tuner assembly and printed circuit board (PCB) assembly. The next section evaluates the changes in terms of the job enrichment "dimensions" of variety, autonomy, task identity and feedback. A brief review of the case is given in a Summary section at the end.

We gratefully acknowledge the help and cooperation of numerous members of the Leaside plant. The Personnel Department was most helpful in obtaining permission for the study to take place and arranging access to the site. Engineering Services and Production Department personnel gave valuable advice and guidance on the actual operations we examined. We would also like to thank the operators, who kindly put up with our observations and questions on the job.

BACKGROUND

The principle of breaking jobs down into very small elements has certain advantages in organizing a production system. Smaller job elements take less time to learn; therefore, there is less training time before an operator can perform at full speed and competence. A production system in which the jobs have been reduced and simplified to a point where most jobs can be learned quickly and involve only trivial skills, requires little in the way of employee skill or special ability, and is consequently less vulnerable to manpower scarcities. The system is protected against problems of employee absenteeism and turnover because a substitute operator can be found and trained very quickly.

In an industrial enterprise such as the mass-production of electronic assemblies, the above principle leads to the familiar assembly line layout. The overall task is broken down into a sequence of different small tasks. Each of these tasks can be performed by an employee with relatively little skill or training. Each task is performed at a "station", equipped with the necessary tools and supplied with the necessary materials. The operators are stationed along a "line", in order of the sequence of jobs they do. The product on which they perform their operations is moved from station to station by a conveyor belt. By controlling the speed of the belt, the rate of output of the line is controlled.

Besides the advantages for the production system noted above, the assembly line way of operating has certain characteristics from the point of view of the operators. Firstly, there is little demand on the operator's knowledge or mental abilities - the jobs are quickly learned and easy to do. Secondly, the repetition soon becomes mechanical and there is little demand on the operator's attention - he or she can think of other things. Thirdly, the operator plays a very small part in the overall task of assembling a complete product unit, so that there is little reason for him or her to feel personally responsible or concerned for ultimate results. Fourthly, the constant movement of the line and the forced interdependence of the sequential jobs means that no operator can vary his or her speed of work. One cannot leave the line for a rest unless replaced by a substitute; when the line stops, everybody stops.

It is easy to see how this arrangement of jobs has evolved in line with "scientific management" theory

(e.g., Taylor[1], 1911). The maximizing of efficiency through the simplification and standardization of jobs was the essence of Taylor's approach; yet, he specified that "The task is always so regulated that the man who is well suited to his job will thrive while working at this rate during a long term of years and grow happier and more prosperous ...".

In the 1950's and 1960's there has, however, been a growing concern that monotonous and trivial jobs are a contributing cause of absenteeism, turnover and poor morale among employees. Personnel managers and industrial engineers, in industries which have relied heavily upon assembly line production, are trying to develop alternative or modified arrangements which are more congenial and satisfying to employees. The Philips organization shows this concern in its encouragement of such efforts in its constituent factories and offices.

At Philips' Leaside plant, the rates of absenteeism and turnover among production employees are well below industry averages, and employee relations have been generally good. Nevertheless, the management has taken steps, within the limits of the given technology, to increase the cycle-time of jobs and to eliminate the "tyranny" of the moving-belt assembly line. The management of the Leaside plant believe that having to work on a fast moving belt, performing a very small part in a long, rapid series of assembly operations, is not good for employee attitudes and satisfactions. They feel that employees who are in a position to put together a recognizably large sub-assembly on their own, and to suit their pace of working to a daily quota rather than to an imposed line-speed, feel better satisfied in the long run, and take a more responsible attitude to their work and to the Company.

The management has, therefore, aimed as a matter of policy to convert away from very short cycle, moving line operations wherever the demands of the technology and production economics will permit. Naturally, they have to meet certain unit cost and output objectives, which are dictated by the market in which the Company competes as a supplier. Similarly, there are certain technical realities in the nature of the industry which dictate that certain operations must be carried out. For instance, the use of solid state technology in set design means that a large number of very small components have to be assembled into a very complex

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[1]F.W. Taylor, The Principles of Scientific Management, Harper and Row, 1911.

circuit. The best way of doing the job is to mount these miniature components on a printed circuit board. Consequently, the entire industry is geared to this way of operating. A manufacturer wishing to depart from this industry practice would have to cope with serious problems of engineering, supply and cost. The innovation risks and the diseconomies of scale which are involved in deviating from industry practice often make it difficult for a manufacturer to change his technology; and the technology, in turn, dictates to some extent the nature of the human tasks to be done.

The guiding philosophy at Leaside is to increase the number of different job elements in each employee's task to the point where further increase would either overtax the employee's learning capabilities, or result in a technical problem of some kind. Some jobs have lent themselves well to this process of job "enlargement". An example is the assembly of chassis-mounted components, such as television tuners and front-controls. In these sub-assemblies, an operator can readily learn the necessary arrangement and techniques and put together a unit in, say, 10 to 15 minutes, using a few relatively inexpensive tools and a plain work bench.

Other operations, however, come up very quickly against limitations of human skill or of storage and work space. For example, in inserting a large number of miniature components in a printed circuit board, no operator can normally memorize the locations of more than 30 or 40 components; also, it is difficult to store sufficient quantities of more components than this within an operator's easy reach. Since the number of components in a typical printed circuit board can be as many as 200 to 300, it is clearly necessary to have several operators working in sequence on each printed circuit board.

The colour television production department at Leaside is housed, as we have already noted, in an open plan area and on one level. The flow of work proceeds from the preparation of miniature electronic components, and the assembly of printed circuit boards and chassis-mounted components, to the mounting of these sub-assemblies together with picture tubes, speakers, etc., into television cabinets. The finished sets are adjusted and packed for distribution within sight of the earliest stages of preparation and assembly. In this case study, we have selected the sub-assembly of tuners and of printed circuit boards to illustrate and discuss the experience of Philips' Leaside plant with job enrichment principles. These particular assembly operations are described in some detail in the next section.

THE LEASIDE EXPERIENCE

> "Job Enrichment has taken much of the monotony out of assembly work by entrusting each operator with the responsibility of assembling, or completing, an entire unit. In addition, it allows the operator to personally tailor her work pace to attain her daily quota.
>
> Where once the employee was just one of a number of operators assembling a single unit with one eye on the constantly moving conveyor belt, Job Enrichment has removed the strain and stress without any sacrifice of quality or quantity. .....
>
> Job Enrichment puts emphasis on the individual and adds more scope and interest to his or her job. It allows each employee to work independent of the others, thus enabling them to see the results of their own efforts. The new production method provides a sense of accomplishment for the employee and encourages "pride in workmanship". Only a Job Enrichment employee can say: "I built that entire unit myself"."

The above passage is quoted from an article in the Company magazine, "Philiscope". The article makes explicit use of the term "job enrichment", and refers specifically to improvements in work variety (scope and interest), individual autonomy and a sense of accomplishment. We are going to examine the operations involved in two different subassemblies: the front control tuner assembly, and the printed circuit board. In each case we try to ascertain the extent to which work arrangements have been changed, the barriers and limitations that have been encountered, and the effects of these changes on the employees.

1. Front Control Tuner Assembly: The assembly of front control tuners involves, first of all, the construction of chassis units from formed steel parts by rivetting the parts together on a power-operated press. The operation requires a routine manual skill; it is essentially repetitive and the cycle is short.

The mounting and wiring of components on the chassis involves a number of fairly simple mechanical operations, including locating a variety of parts on the chassis, securing them with screws, and soldering connecting wires to their terminals. This set of operations lends itself well to being broken down into a series of very short-cycle job elements of, say, from a few seconds to a minute. High production rates are possible using moving belt assembly line techniques. This customary method of production is widely used in the industry for these operations, and was used at Leaside until fairly recently.

The Engineering Services and Manufacturing management at Leaside have, however, evolved job designs and an overall method of operation for chassis sub-assembly which are quite different from those just described. With the objective of enriching and enlarging individual tasks for the benefit of employees, and with due reference to the technical and economic limitations, the new arrangements include discarding the moving belt, and increasing the cycle time of most jobs from a matter of seconds to several minutes. An individual operator, under the present system, mounts and wires a complete front control tuner assembly, taking ten to fifteen minutes in the process, and even "signs" the completed unit with his or her personal mark. The original assembly belt is still in place - but it is used simply as a convenient means of transporting parts and is under the control of the operators.

It must be borne in mind that this sub-assembly operation uses parts provided by other units and departments, and supplies its product to yet others. Therefore, while it is an aim of job design to allow as much freedom as possible to the operators to organize their own schedules and pace of work, there are obvious limits to this freedom. One constraint is that the flow of work should be even and predictable enough not to disrupt the overall flow through other work units. For instance, a pile-up of chassis and wire parts on one hand, and a shortage of assembled front control tuners on the other would cause problems in other sections. The other major constraint is that the output rate of the "sub-system" must eventually match the planned production quotas of the whole system. Operators are expected, therefore, to meet a daily output quota. Apart from this they can work more or less at their own speeds.

Five employees work at the assembly of tuners and are required to produce a daily quota, determined by the overall production quota for the department. The parts to be assembled include the basic chassis, several supporting brackets, and a number of electronic components, which have to be fastened to the chassis with screws. The components have to be connected into the circuitry by soldering at a dozen or so points. The connecting wires are handled, usually, in the form of pre-assembled "harnesses", prepared at a different station by other operators.

The five operators are seated at separate benches, one behind the other. These work "stations" are located alongside the belt but facing at right angles to it; operators can switch on the belt to move assembled units forward to the next station. The first operator attaches the brackets, mentioned above, to the basic chassis; she prepares enough of these chassis units to supply the other four operators, each of whom has the job of mounting and wiring the remainder of the sub-assembly. That is, the five-member group is differentiated into one member doing a preparatory operation for the other four, who all do the same tasks. The job cycle time for the first operator is approximately three minutes, and for the others, approximately twelve minutes. The cycle time is defined as the elapsed time between starting one unit and starting the next successive unit.

A typical work station consists of a steel bench, three feet by two feet, equipped with a power-driven screwdriver and a soldering iron. Each of the five operators sits on a high stool with a backrest; on her right is the conveyor belt, along which arrive the chassis units. On her left is an aisle, where components are brought to her and stored ready for use, either beside the bench or in small bins on the bench itself. The work space is just large enough to accommodate the work in hand and enough supplies to keep the operator busy; it is small enough for the operator to encompass all her tasks without having to get up from her seat.

Consider, first, the four operators doing the main assembly. Each operator takes a prepared chassis and places it on the bench before her. She takes components, one at a time, from her storage bins and secures them in their proper places on the chassis with metal screws; the power tool is suspended conveniently above the work bench. She then solders the connecting wires to the terminals of the components; all the wires are pre-cut, with ends bared, and most of them are already assembled

into harnesses which have been delivered to her bench side. The soldering iron rests in a stand to the right of her bench; she uses resin-cored solder which fluxes the joint automatically. The wiring pattern is quite complex and normally takes two or three weeks to learn.

The first operator in the group, attaching the brackets to the basic chassis, has a simpler and shorter-cycle job than the other four. However, she works at a similar work station and is considered one of the group. The job of screwing a number of brackets on a chassis in a 3-minute cycle differs from the others in degree rather than in nature. Compared with the usual assembly-line job, it is a relatively large job. The job is, in fact, intermediate between the old "line" system and the four assembly jobs existing under the new arrangement. The first operator is under pressure to keep up with the other four -- but has some freedom to build up a stockpile and then rest for a while. At any rate, she is not "tied to the line".

It is evident from the above descriptions that the job of assembling tuners is highly organized and that it is integrated into a complex production system. The job is highly organized in the sense that a prescribed set of activities must be learned and followed, if the product is to turn out properly. The operator must take a chassis from the belt on her right, position it on her bench, select components from her standardized storage bins, and make up the assembly according to a rigidly prescribed pattern. This practice is accepted as good common sense.

The job is highly integrated into the system in that chassis, components, harnesses, etc., must all be supplied at the correct rate and in specific locations; for instance, the operator should never have to go and look for harnesses, much less have to make them up herself. All this is arranged by management, as designed into the system by industrial engineers, so that an orderly flow of work proceeds to achieve the desired rate of output.

Thus, the operator can do more or less as she likes, provided she does not disrupt the overall workflow, and provided she meets her output quota as set by management. On the basis of a forecast demand for television sets, a production system of sufficient capacity is set up; and, on the basis of orders received, daily production quotas are set up. The activities of an individual operator, at her bench in the tuner assembly group, must be patterned in the service of these ends; they must conform to the overall

production system which integrates and coordinates the total operation. Once again, this is seen as good common sense. As Taylor observed:

> "...to work according to scientific laws, the management must take over and perform much of the work that is now left to the men; almost every act of the workman must be preceded by one or more preparatory acts of the management which enable him to do his work better and quicker than he otherwise could."
>
> (Taylor, 1911)[1]

The job does leave some room for operator independence. While the scope for this may seem to an observer to be very small, there is a considerable difference from the standpoint of the operator between the old assembly line and the new arrangement. She now has the freedom to work very fast when she feels like it - then to "take it easy" for periods of time as long as she keeps the supply of panels ahead of line requirements and produces her quota by the end of the day. Operating in this up and down fashion will not interfere with other operations or people. Therefore, within reasonable limits, she can leave her station vacant and visit the rest room when it suits her.

On the assembly line, none of this flexibility can be tolerated; the short cycle times mean that speeding up and then "coasting" does not provide enough slack to even smoke a cigarette. If an operator falls behind for any reason, the flow of work on the line is distorted and slowed down. The operator is required to maintain a steady level of activity. She cannot leave the line until a relief operator is found - so that visits to the rest room cannot be made so freely.

Operators in the tuner assembly group commented very favourably on this aspect of the change: while the line was a cheerful, sociable place to work "when you were feeling good", the pressures tended to make one "nervous"; the new bench arrangement is "more relaxed and less tiring".

While this small increase in independence is certainly valued by the operators, there are two other aspects which appear to have as much or more importance for them.

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[1] Ibid., p.3

The first is the increase in cycle time, with its longer list of things to do, and the fact that a complete sub-set of operations is carried out each time. This offers more of a technical and mental challenge to each operator. Some of them still claim that they can do the job without really thinking about it, but even this appears to reflect a pride in accomplishment. Jobs "on the line" are often simplified to the point of being "foolproof", and thus present little in the way of challenge. The practice of bench operators "signing" the finished assembly with a personal distinguishing mark encourages the sense of accomplishment. There is an immediate sense of responsibility, because a unit which is found to be faulty at the testing stage can be traced directly back to the operator who assembled it.

The second important difference lies in the idea of personal "territory". On the assembly line, the sense of having one's own "spot" is limited and uncertain - everything belongs to the Company, and the operators simply "work on the line". With the new bench arrangement, however, there is a very strong impression of "ownership" - "my bench", "my soldering iron", "my station". The engineers who actually implemented the change were struck by the serious concern that some operators had that "their" benches were in some way different to, or inferior to, the others. Bench tools, far from being held in common, are jealously guarded.

On the assembly line, when the line stopped for a rest break, everybody stopped. Under the new arrangement, operators tend to take these breaks together by mutual agreement, but only if it suits them; the decision is made on a personal and social basis.

All of the operators in the tuner assembly group responded favorably when asked how they felt about this work arrangement. The comment which recurred most often was that it was a more "relaxed" atmosphere. Certainly, the atmosphere of the whole department is one of people working quietly together in small groups, distributed in an orderly way about the premises. This contrasts strongly with the typical moving-belt assembly operation, where all activity seems focussed on the clatter and glare of the line, and the pervading atmosphere is one of tension and mechanization. While we did not observe the line which existed previously, we were assured by those who had worked on it that the atmosphere was as just described. We were also assured, by management and operators alike, that rates of output have not suffered under the new arrangements.

It seems possible that the assembly line system of working <u>could</u> be a better vehicle of satisfactions for

certain kinds of people. In fact, one operator is reported to have felt that she used to have plenty of people to talk to on the line, but felt cut off and lonely under the new arrangement. The opinions or comments of her fellow-workers in this regard were not recorded. It is clear that social forces among operators can play a greater part under the new arrangements; under the old, the line tended to dictate relationships.

To sum up very briefly, the re-design of jobs and work arrangements has resulted in increased cycle times, elimination of the moving belt, and more opportunity for the operators to manage their own time. Enrichment of jobs has been achieved with respect to a deeper sense of involvement and of personal worth. The employee response comes through as expressed satisfaction with the "more relaxed" work environment, and "more interesting" jobs.

2. Printed Circuit Board Assembly: The printed circuit board (PCB) is a comparatively recent innovation in the large-scale production of electronic circuitry. The PCB is, essentially, a flat rigid piece of plastic laminate, about the size of a sheet of writing paper, and approximately 1/16th of an inch thick. The electronic components on these PCB's are all very tiny (miniature) solid-state devices, each equipped with end wires for connecting it to the PCB circuit. Thus, a PCB is assembled by simply inserting the end wires of, say, 200 to 300 miniature components in the appropriate holes and soldering them in place.

   a) Preparation of components: As the components are supplied to the plant, each has a pair of wires sticking straight out; these must be bent so that they can be inserted into the holes in the circuit board. Some of the components are supplied on tape and are cut and bent on semi-automatic forming machines, but many components must be cut and bent by manual insertion in a small press. The bending operator sits at a bench and feeds the components, one at a time, into a press, which is actuated by a foot switch. The job is highly repetitive and requires very little skill. A battery of press stations feeds a stockpile of components.

   b) Assembling the components: The second operation is the inserting of the components in the circuit board. The basic task is to pick up a component and stick its two wire prongs through the correct pair of holes in the PCB. A single board may take 200 or 300 components.

When the PCB assembly operation is organized on a moving belt assembly line, the number of possible operators is limited only by the number of components and the practicalities of the line length and the required rate of output. A long line with many operators will have the advantages, described above, of low-skill, quickly-learned jobs. As the line gets shorter and the operators fewer, the learning time becomes longer and the operators less interchangeable. Once the line speed is determined (in accordance with the production plan) and the size limit is specified, then the engineering solution, generally speaking, is to have as many operators as will fit on the line, with each having enough to do. For instance, a line might accommodate 60 operators, each placing 4 or 5 components. Individual cycle times would be a few seconds only.

The PCB line at Leaside is designed to maximize the cycle time in this operation and to avoid using the moving belt. However, there is a physical limitation to the number of different components which can be placed at any one work station and, generally, each operator will not have more than 30 or 40 components to handle. Therefore, it is necessary to employ at least six operators to contribute in sequence to the assembly of a board with more than 200 components.

The job involves the mental skill of remembering which locations on the board correspond to which storage bins; and the manual skill of handling the tiny components smoothly and without fumbling. The operators sit in two short rows, as each operator finishes her sequence, she passes the assembly to her neighbour by sliding it along to the left or right: the two rows sit back-to-back in a small area enclosed by their benches. There is no moving belt. For rest periods, the operators stop work as a group. Since there is a logical sequence of operations, no operator begins her part until the previous part has been done. While there is no moving belt to fix the speed of work, and the individual cycle times are much longer than on a typical mechanical line, the operators are nevertheless dependent upon each other in series, as in any production line.

Operators say that errors and omissions in the placing of components do occur, but are usually noticed by successive operators who recognize discrepancies in the pattern and get the matter rectified on the spot. The sixth operator checks

over the entire board, which requires considerable skill in pattern recognition. Thus, there does exist an internal quality control and feedback system in the line. The individual cycles average approximately two minutes.

The PCB now has all its components, but they have been mounted loosely by simply inserting their projecting wires, properly bent, into the holes in the board. The components have yet to be fixed in permanent electrical connection by soldering.

c) The soldering operation: The next operation is, therefore, to solder the wires in place. This is done on a flow solder machine in which the PCB, after having had flux applied, is carried over a "wave" of molten solder. Next, the wires that protrude too far must be clipped off. Clipping is done by operators seated at separate benches beside a small conveyor-line which follows the soldering operation. Clipping is a very simple, repetitive job; the operators express no distress with its apparent monotony - "a job is a job!", they say.

The soldering and clipping sequence, being geared to the fixed rate of the soldering machine and the little conveyor, regulates the working speed of the operations which precede it and also those which follow it. Thus a short series of mechanically programmed operations in an otherwise humanly flexible system has a pronounced regulatory effect on the system.

d) Circuit testing: The PCB is, at this stage, a completed unit, ready for testing. The tester's job consists of probing the circuitry at certain points, following a prescribed procedure, and reading the responses of the instruments on the test bench. Some components are adjusted and circuits which fail to meet all the specified values in the test procedure are set aside for re-working.

When we compare the PCB assembly arrangement with the tuner assembly, previously described, it is evident that the job enrichment principles have been less fully realized in the former. Job cycle times are shorter; jobs are linked together in sequence in such a way that each person's job depends on the previous jobs being completed, before it can be started.

In the tuner assembly arrangement, cycle times have been increased and jobs have been made more interesting and independent by grouping several job elements together under one

operator - for example, assembling a complete tuner except for the chassis and brackets. To go further in this direction with PCB assembly, a single operator would have to insert a larger number of miniature components into a board (the board cannot go to soldering until all the components are inserted). This is not practical because one person normally cannot learn more than 30 or 40 components. Even if some operators could learn to handle a greater number, the satisfactions to be had from inserting, say, 100 components into a board may be significantly greater than those from inserting 30 or 40. Another conceivable way of increasing cycle time and variety in PCB assembly would be to combine several simple jobs under one operator - e.g. clipping, soldering and testing. However, if this were done, for each operator now kept busy on these three operations, it would be necessary to have three stations fully equipped to do all three jobs; that is, three sets of testing equipment would be required, three clipping stations, and three soldering stations. The extra equipment, space and skills needed would be considerable, as would be the extra cost.

In short, the present way of operating appears to be a reasonable compromise between the desire to give individual operators more congenial work on one hand, and the practical limitations of existing technology, on the other. The existing arrangement of jobs is dictated to a large extent by the printed circuit board technology and by the required production rate. Within these contraints, there seems to be little or no room for further job enrichment.

JOB ENRICHMENT

Job enrichment theory holds that there are certain qualities in a given job which are of value to the employee who has that job to do. The degree of job enrichment depends on how highly the job rates on these particular dimensions. The dimensions are: variety, autonomy, task identity and feedback.[2] In this section we shall take the changes in work arrangements which have been described and evaluate them against each dimension in turn.

a) Variety refers to the number of different things an employee gets to do in the course of his normal duties. There is an evident relationship

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[2] J.R. Hackman and E.E. Lawler, "Employee Reactions to Job Characteristics", Journal of Applied Psychology, 1971, 55, 259-286.

between variety and the number of task elements in a job. The changes which have increased cycle times have, in a general way, increased the amount of variety in the jobs concerned. This certainly applies to tuner assembly. However, it should be borne in mind that some of these task elements are very similar to one another; for instance, for an employee to insert 20 pieces in each of 200 boards in a day is not much more monotonous than to insert 40 pieces in each of 100 boards in a day.

Task elements which require different kinds of operations, such as testing, clipping and rivetting, usually require special tools, equipment and skills; this is a barrier to variety enrichment because it it much more expensive to train several operators and equip each one with several kinds of gear, than to have each specialize in one particular operation.

The size of this barrier depends on the cost of the equipment and training involved. While the cost may not appear very large in absolute terms, it may appear quite large in a departmental budget. That is, the apparent barrier depends on the organizational level at which the decision is made. In some cases, the ability of certain employees to handle various kinds of equipment and skills is also an important factor.

b) Autonomy refers to the freedom of the employee to decide what she should do and when. Under the new arrangements in the tuner assembly group, the operator has more control over her rate of working and the management of her own time, within the overall constraint of the daily quota. The operators perceive this as very important. On the moving belt, there was hardly any opportunity for an operator to choose her pace of working or to leave her place at will. Individual autonomy appears to be higher on the tuner assembly than on the PCB line, which is no better than a moving belt line in this respect.

c) Task Identity, in the sense intended here, refers to the employee's seeing herself as involved in a coherent process which has an intelligible and useful outcome, and in which she can take some personal pride of accomplishment. The terms "wholeness" and "meaningfulness" of task

are sometimes used in this connection. The completion of a tuner sub-assembly and "signing" it with her own mark gives the operator a sense of personal accomplishment. This sense of the "wholeness" of the task and of making a valuable contribution was absent on the moving belt assembly line. This opportunity to achieve a sense of accomplishment is not evenly distributed; for instance, it is much less apparent in the mounting of brackets on the chassis, where the job cycle is relatively short, than in assembling the rest of the tuner. On the PCB line there is little opportunity to achieve a sense of task identity.

All the assembly jobs are performed within view of the total operation, including the installation of the assembled "modules", picture tube and speakers in the television cabinet, and the final testing, adjusting and packing of the cabinet. Thus, all operators are aware of the final product and can readily see the parts they play in its production. It is doubtful, however, whether this awareness would be any less under the moving belt, short-cycle system.

d) Feedback refers to the sending back to the employee of information concerning the outcome of her work. This information might be on the quality and quantity of her output, how it compares with the output of others, and how it rates in the opinion of fellow-workers and supervisors; or it might be on the performance of the product further on in the process, or in the hands of the ultimate user.

On the moving belt assembly line, individual jobs tend to be short in cycle and trivial in content. Operators are virtually anonymous, and information fed back on quality, quotas, etc., tends to be impersonal and general. (There may, of course, be some very direct personal "feedback" from neighbours down the line). Under the new arrangements, however, there are signs of formal, personal and particular feedback to individuals. The operators who insert components in printed circuit boards have their own quality control system, in that each operator keeps an eye out for mistakes made at previous stages, and the last operator in line checks out the entire board before it goes to the soldering machine. All completed sub-assemblies have certain of their circuit para-

meters checked at the test benches, and those which do not meet the specifications are rejected and re-worked.

In the case of the front control tuner assemblies, a unit rejected for circuit faults can be traced directly to the operator who assembled it, because of the "signature". However, there does not appear to be any formal arrangement for informing operators of their success or reject rates.

In general, the enrichment along these four dimensions which has resulted from the efforts of the management to re-design jobs is significant but not large. It is significant in the sense that the new arrangements are seen by the operators as having made a difference; the "tyranny" of the moving belt has ceased and employees are aware of a more relaxed atmosphere and more freedom. The enrichment is not large, in the sense that the changes are "horizontal" rather than "vertical", in Herzberg's terms[3]. That is, cycle times are expanded usually by adding similar task elements (horizontal); the barriers to grouping task elements of different kinds, degrees of complexity and degrees of difficulty (vertical) have been discussed above.

By and large, the change seems to be accepted by operators and management as the most that can be done in the circumstances. It is the most that can be done to make the work more congenial, given the technical realities of having to perform a specific and relatively complex assembly operation as economically as possible.

SUMMARY AND DISCUSSION

The general management philosophy at Philips is conducive to change in work arrangements wherever the lot of employees can be improved without actually impairing the economic health of the organization as a whole. The approach is, essentially, to increase the amount of scope, interest, variety, etc. in an employee's job to a point where further increase would be distressing to the employee or would cause serious technical problems.

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[3]Frederick Herzberg, "One More Time: How Do You Motivate Employees?", Harvard Business Review, vol. 46, 1968, 53-62.

This study reports on two specific cases at Philips' Leaside plant in Toronto. Job enrichment principles and problems are exemplified, using the moving belt assembly line as a theoretical reference base. One case -- the assembly of front control tuners -- provides an example of an operation which has accepted job enlargement quite readily. The tuner constitutes a complete "module" of a TV set; under the new arrangements, a complete tuner can be assembled, for the most part, by one operator. The operators are very pleased with this situation, compared with working on the moving belt. They now work as a group of five, and report considerably more interest and autonomy in their work.

The second case is the assembly of printed circuit boards. This is a complex operation which has been technically rationalized and organized to a point where it does not require very complex skills. It involves the assembling of a large number of miniature parts into a small single unit (the PCB). Because of its overall complexity, it cannot reasonably be done by one person, no matter how highly trained. In fact, a compromise has been reached between the long-line approach, as typified by the moving belt assembly line, and the group approach exemplified above in assembling front control tuners. The mechanical line is dispensed with, except where a machine operation is clearly the most economical (the soldering machine); trivially small task elements (sticking different components in the PCB) are grouped together, up to an employee's capacity to learn them. Thus, PCB assembly is a line operation, incorporating as many job enrichment elements as the technical constraints will permit.

Both of these operations, which are typical throughout the industry, are usually performed on moving belt or conveyor assembly lines. The cases provide an excellent illustration of the opportunities available for job enrichment and the limitations that may be encountered.

An evaluation of the progress made at Philips in terms of formal job enrichment dimensions indicates that the change is significant, but not large in an absolute sense. There are two important qualifying factors: i) employees in the section where more progress has been made, perceive the change, quite definitely, as an important and favorable one; ii) the technical barriers to further job enrichment in the section where less progress has been made appear quite formidable.

The PCB experience, in particular, confirms the

finding in the CIL case[4], that it is not easy to significantly increase the amount of employee self-control and involvement, or the variety and interest in the jobs in manufacturing industries. In both cases, very competent local managements, operating under favorable corporate policies, have made serious efforts to achieve changes in working arrangements. In both cases, the results have been commendable, but have not registered strongly on the job enrichment "scales". In a very different kind of work situation, a small office unit at Miracle Food Mart head office[4] achieved a more dramatic change. In this case the technical factors and external obligations of the group placed few limitations on the internal change toward more autonomy, variety, etc.

We ought not to make sweeping generalizations on the basis of only a few cases; but these cases do suggest a general idea. They suggest that the complex technical framework which has grown up around most manufacturing operations has come to dictate just what the people in that framework must do. If the management desires to change, for any reason, the content and structure of the jobs of their employees, they must be prepared to modify that technical framework. Although this need not always involve drastic changes, it may do so in some cases where the basic technology is the main factor (e.g., printed circuit boards).

It follows that where changes are desired in the work arrangements of a programmed, complex technical system, an integrated management approach is required. It may be necessary to contemplate the changes in terms of several factors, including product and process design, and operating, training and equipment costs. A staff department, attempting a change programme as part of its own regular duties and budget, is under a handicap in this respect.

In short, the cases show that a valuable amount of improvement in human work arrangements can be achieved, even under fairly rigid conditions; however, it is difficult to do much without running into serious technical and

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[4]I. Meadows, Ontario Ministry of Labour, Research Branch; Employment Information Series, no. 8. "A Case Study in Job Enrichment - CIL Paints Division, Vaughan Centre", November 1974; and I. Meadows, Ontario Ministry of Labour, Research Branch; Employment Information Series, no. 14. "A Case Study in Job Enrichment - Miracle Food Mart", June 1975.

economic obstacles. Further progress would appear to require active top management involvement, beyond simply providing policies encouraging job enrichment. As Einar Thorsrud says, with regard to future possibilities:

> "The re-design of jobs and organizations ... ... includes a search for entirely new ways of dealing with the allocation of resources on all levels, including workers and staff as well as management... the institution must provide enough time and resources to enable the new forms of organization to take root ..."[5]

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[5] E. Thorsrud, "Job Design in the Wider Context", in Design of Jobs, L.E. Davis and J.C. Taylor (eds.), Penguin, 1972.